DESIGNING AND MANUFACTURE SOLAR TURBINE

MOHAMAD YAZID BIN MOHAMAD YASSIN

Report submitted in partial fulfillment of the requirements for the award of
Diploma in Mechanical Engineering

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

NOVEMBER 2010

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project report and in my opinion this project is satisfactory in terms of scope and quality for the award of Diploma in Mechanical Engineering.

Signature:
Name of Supervisor:
Position:
Date:

STUDENT DECLARATION

I hereby declare that the work in this report is my own except for quotations and summaries which have been duly acknowledged. The report has not been accepted for any degree and is not concurently submitted for award of other degree.

Signature:
Name:
ID Number:
Date:

ACKNOWLEDGEMENT

Praise to God for His help and guidance that I am able to complete the task of the Final Year Project. I am thankful and grateful to my supervisor, Mr Idris Bin Mat Sahat for his advice and knowledge that he shared in the completion of the project. I appreciate his help for me while I am doing the Final Year Project from week 1 to the day I finished my Final Year Project.

I also would like to thank all my friends who have been really helpful during the course of the conducting the Final Year Project. I also would like to thank laboratory assistants who have help me in sharing knowledge in conjunction with the project that I am conducting.

I sincerely grateful to my parents for they love and sacrifice that they had for me throughout my life and their support for me in all my activities that I have done. I also wanted to that other people who have directly or indirectly help in the completion of my Final Year Project. I sincerely appreciate all your help.

ABSTRACT

This report shows the design and fabrication of a solar turbine. The objective of the report is to develop the procedures to design and fabricate a prototype solar turbine to generate energy. This report also describes the ideas and products of current solar turbines which are available around the world. Design generation is showed and solid three dimensional structures modelling of the solar turbine was developed with computer aided design software. Material selection and the reason behind the selection are shown based on criteria predetermined. Based on the selection, aluminium alloy and mild steel is selected. The result from the testing of the solar turbine shows that the solar turbine able to generate electricity. Ideas of improvement for the solar turbine also provided to further improve the solar turbine.

ABSTRAK

Laporan ini menunjukkan lukisan dan pembuatan turbin solar. Objectif untuk laporan ini adalah untuk menghasilkan prosedur-prosedur untuk menghasilkan lukisan dan pembuatan prototaip turbin solar yang menjana tenaga. Laporan ini juga menerangkan tentang idea-idea dan produk-produk turbin solar yang terdapat di serata dunia. Generasi lukisan telah ditunjukkan dan permodelan struktur-struktur pejal tiga dimensi untuk turbin solar telah dihasilkan menggunakan perisian lukisan bantuan komputer. Pemilihan material dan seba-sebab pemilihan telah ditunjukkan berdasarkan criteria yang telah ditetapkan. Berdasarkan pemilihan tersebut, aluminium aloi dan logam asli telah dipilih. Keputusan daripada percubaan turbin solar tersebut menunjukkan ia mampu menjana tenaga elektrik. Idea-idea pembaikan untuk turbin solar juga diberi untuk improvasi turbin solar tersebut.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This project title is ‘Designing and manufacture Solar Turbine. A solar turbine or also known as solar convection turbine is a product which generates energy with renewable energy source. It uses the concept of air convection to generate energy.

1.2 PROJECT BACKGROUND

This project is about designing and manufacturing a solar turbine. A solar turbine is a renewable energy plant whereby it generates energy by converting kinetic energy from air movement into electricity. Solar turbine uses 3 concepts which are greenhouse effect, buoyancy effect and power generation. The air is heated through greenhouse effect whereby it is heated by sun’s radiation under transparent material (such as glass). Hot air is less dense than cold air thus hot air will rise. This phenomenon is called buoyancy effect. The air then moves upwards, through a channel whereby there is/are turbine(s). The air movement turns the turbine, and the kinetic energy from the turbine is converted by a motor into electric energy.

1.3 PROBLEM STATEMENT

Nowadays, fossil fuel is the main energy source, however it will be depleted. Therefore, a renewable energy source should be applied as alternative energy source. The alternative way is using solar turbine to generate energy.

1.4 PROJECT OBJECTIVE

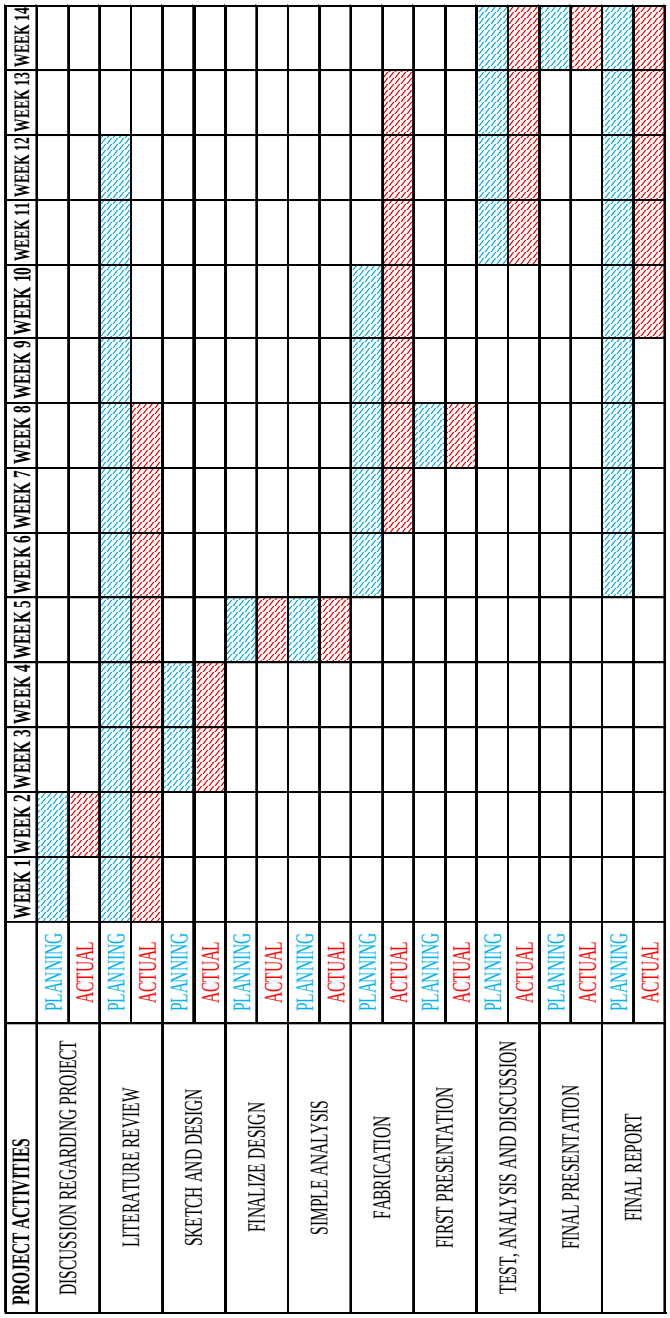
The main objective of this project is to design and fabricate a prototype solar turbine to generate energy based on mechanical engineering method.

1.5 PROJECT SCOPE

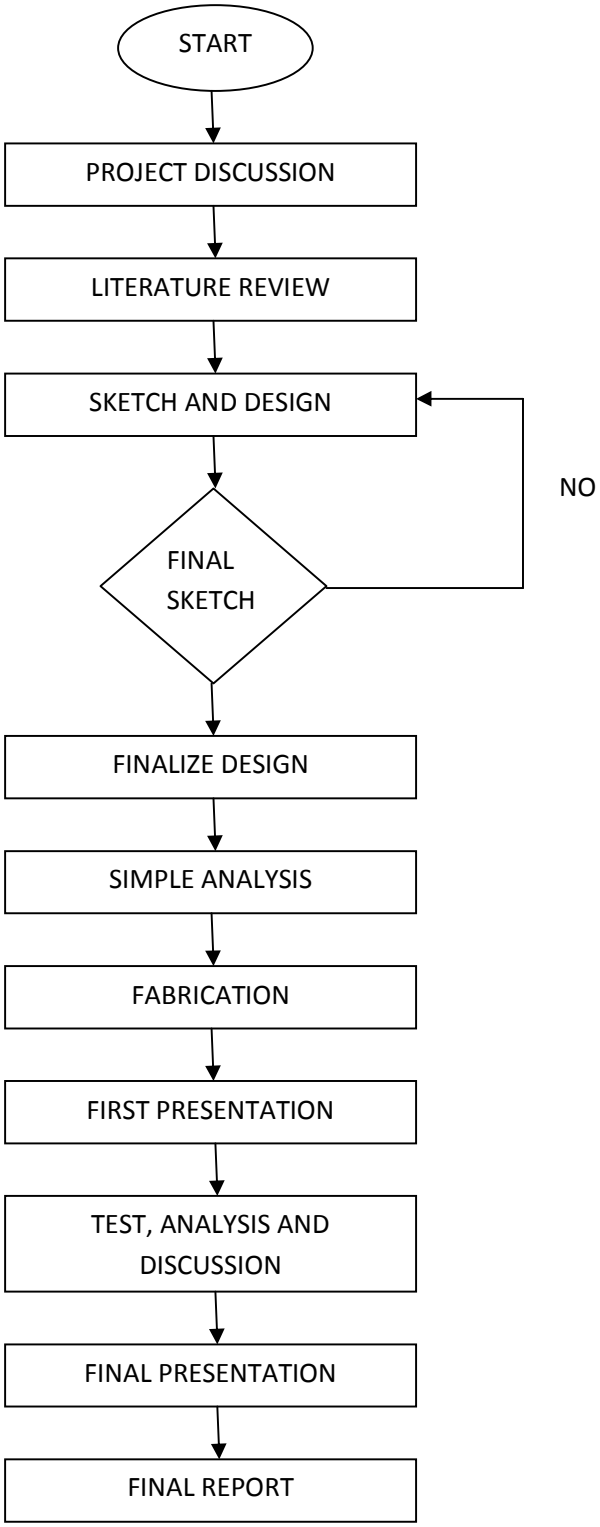
1. To apply all related topics which are learned during the course Diploma of Mechanical Engineering such as industrial design, fluid mechanics and dynamic in product design and efficiency.
2. Final design of the project is illustrated in 3D by using Solidwork software.
3. To manufacture a prototype solar turbine that able to generate electricity.
4. Fabrication of a prototype solar turbine in a small scale.

1.6 GANTT CHART

Table 1.1: Gantt chart



1.7 FLOW CHART



CHAPTER 2

LITERATURE REVIEW

2.1 LITERATURE REVIEW

2.1.1 Solar Turbine 1

Solar turbine or Solar Convection Turbine is a turbine which generates electricity by natural convection of fluid by exposing the fluid to sun's heat. When fluid is heated, the density decreases, due to the increase of gaps between molecules. The area which is exposed to heat will become less dense, thus the denser fluid will move downward, causes the movement of fluid. This movement is called convection.

The ideas of producing solar turbine have been circulating among researchers for years starting from the 20^{th} century when a Spanish Colonel called Isidoro Cabanyes proposed it in a scientific magazine but there are few efforts on producing one. One of the ideas came from Dr Alan Williams, a freelance solar energy researcher.

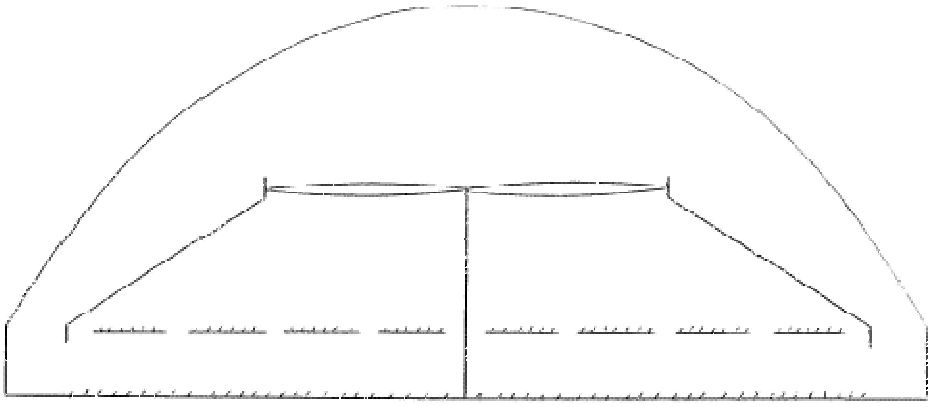


Figure 2.1: Dr. Alan Williams solar turbine idea (Ref. 1)

His idea was to build large sealed ground level solar conductors. The convective energy conversion cycle involved requires no heat rejection and may allow the conversion of solar energy into electricity with very high efficiency. Based on Figure 2.1, the outer dome and inner nozzle are made of transparent material. Inside the dome contains air at atmospheric pressure and is sealed to the ground. The solar absorber is placed above the ground level with substantial gaps to allow air flow. The ground is also covered with solar absorber. A horizontal wind turbine is placed in the center of the dome with its vanes in the throat of the nozzle. The solar absorber acts as a heater warming the air which then rises because of buoyancy effect. The air then flow through the nozzle. The constriction will cause the air to flow in a high velocity. The kinetic energy of the air flow will be taken by the turbine, generating electrical energy. The air then rises to the top of the dome, and eventually cooled, causing it to flow downwards. It will be heated again by the solar absorber. This will cause a cycle, which is called convection.

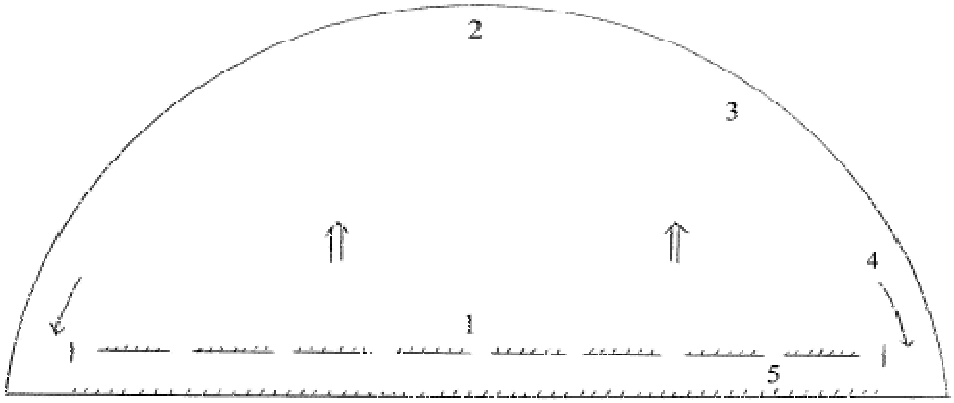


Figure 2.2: The flow of air movement inside the solar turbine (Ref. 1)

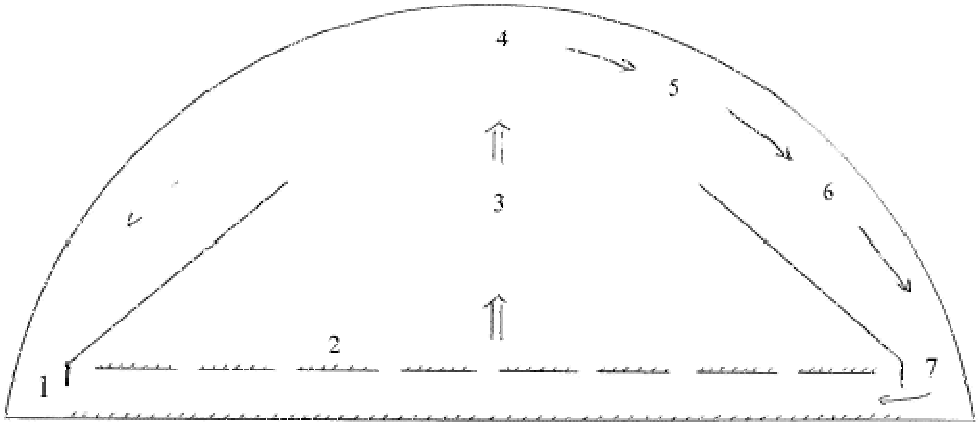


Figure 2.3: The flow of air inside the solar turbine (Ref. 1)

2.1.2 Solar Turbine 2

Secondly is a project lead by Robert J. Rohatensky called Solar Heat Pump Electrical Generation System or SHPEGS. The project is to design and build a system that uses a combination of direct and indirect solar collection to generate electricity and

store thermal energy in an economical, environmental friendly, scalable, reliable, efficient and location independent manner using common construction materials. The system is called “Energy Tower”.

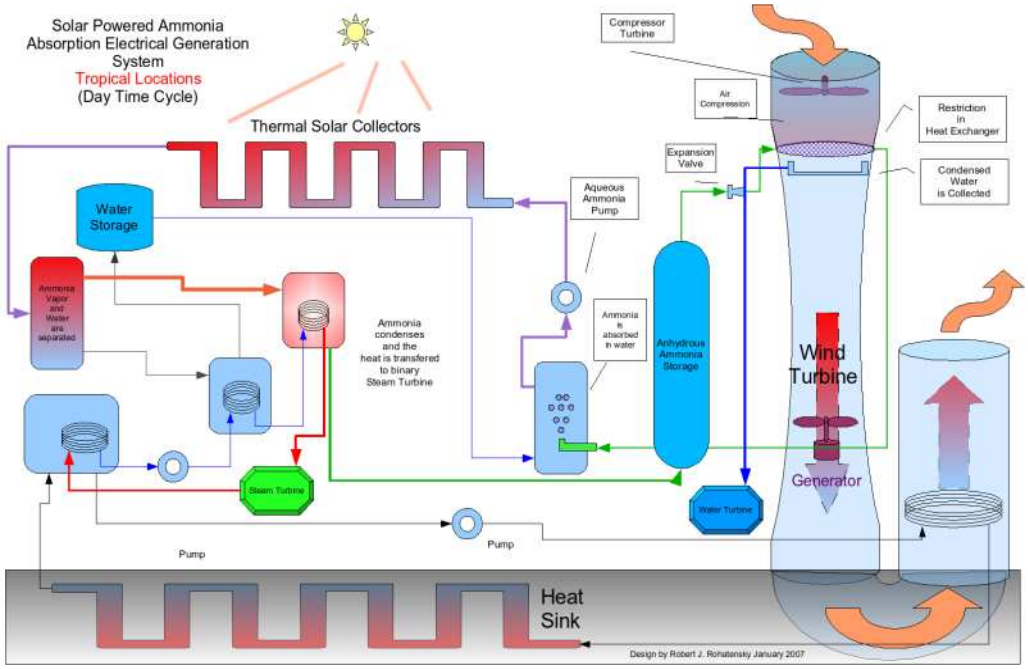


Figure 2.4: SHPEGS illustration (Ref. 2)

The system is divided into two parts, the tower and the thermal solar collectors. The thermal solar collectors absorb heat from the sun directly and warm up the ammonia. In the tower, as hot air enters, it will heat the ammonia. The air then flows to the wind turbine. The kinetic energy will turn into electricity. Excess heat then absorbs by the heat sink and the air then flows out of the tower.

2.1.3 Solar Turbine 3

Third was a prototype, build in 1982 by German Ministry of Investigation and Technology, in collaboration with Spanish Power Company Union Fenosa in the town of Manzanares, Madrid.

Figure 2.5: Manzaranes Solar Tower (Ref. 4)

The medium-scale working model had a height of 195 meters and diameter of 10 meters with a collection area of 46,000 m^2 obtaining a maximum power output of 50kW. The pilot power plant operated approximately eight years, but “encountered severe structural instability close to the tower due to induced vortices”, and was decommissioned in 1989.

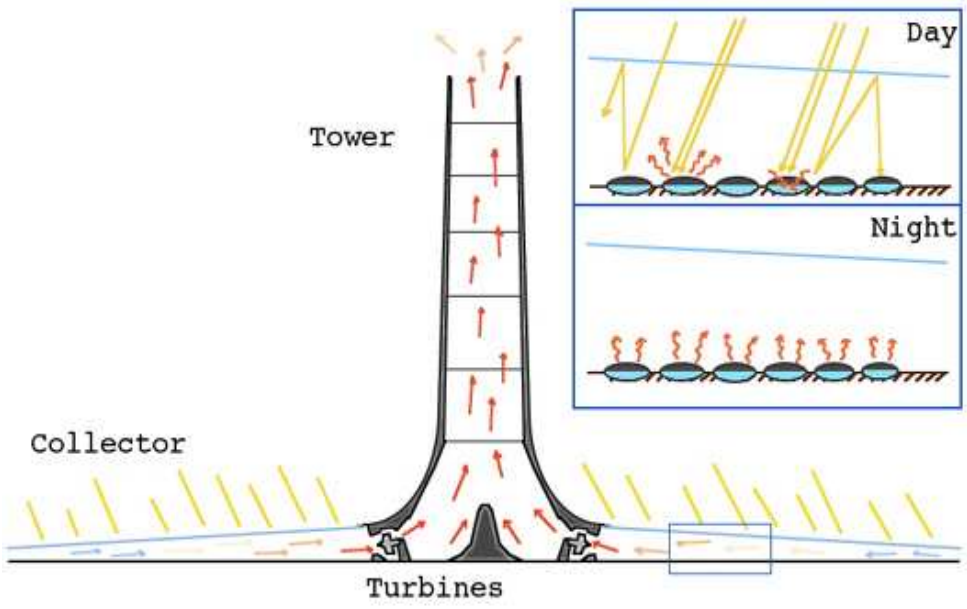


Figure 2.6: Illustration of air flow in Manzaranes Solar Tower (Ref. 4)

The design is based on 3 thermal principles, greenhouse effect, buoyancy effect and air movement drives the turbine to generate electricity. The sun's radiation will heat the air below the glass, in which the heat can't escape and flows towards the chimney. The air flow will turn the turbines, generating electricity. The hot air then continues to rise out of the chimney into the atmosphere.

2.1.4 Solar Turbine 4

Fourth is a project of solar tower in Namibia. The tower will be build with a height of 1.5 km and 280 m wide. The solar updraft towers could potentially produce 400MW of energy, enough to power Windhoek, the nation's capital. The idea was proposed by a company called Hahn & Hahn. The tower also functions as a 37 square km of greenhouse.

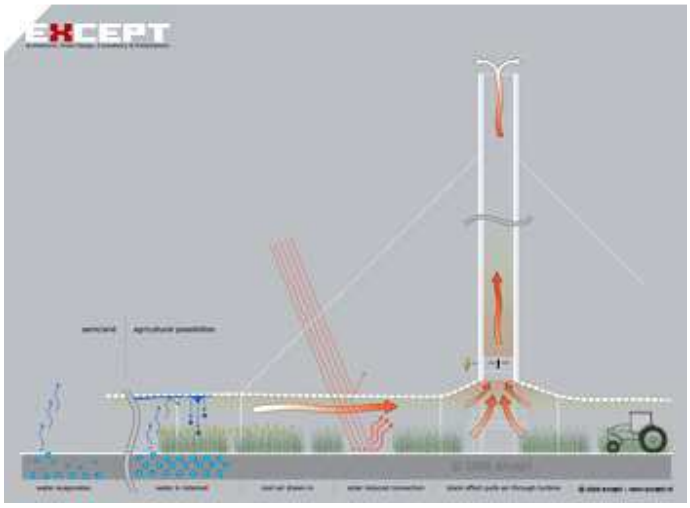


Figure 2.7: Illustration of solar tower in Namibia (Ref. 6)

Similar to the prototype build in Manzaranes, the solar tower generate energy by using sunlight to heat the air within a vast greenhouse situated at the base of the chimney. As the hot air rises, it is funneled into reinforced concrete chimney, driving through series of wind turbines which will generate electricity.

The structure's greenhouse base provides the environment to allow crops to grow, which will then allow the plant to provide energy at night. The water used for crops is heated during the day and transfers this energy at night.

CHAPTER 3

METHODOLOGY

3.1 DESIGN GENERATION

3.1.1 Sketch 1

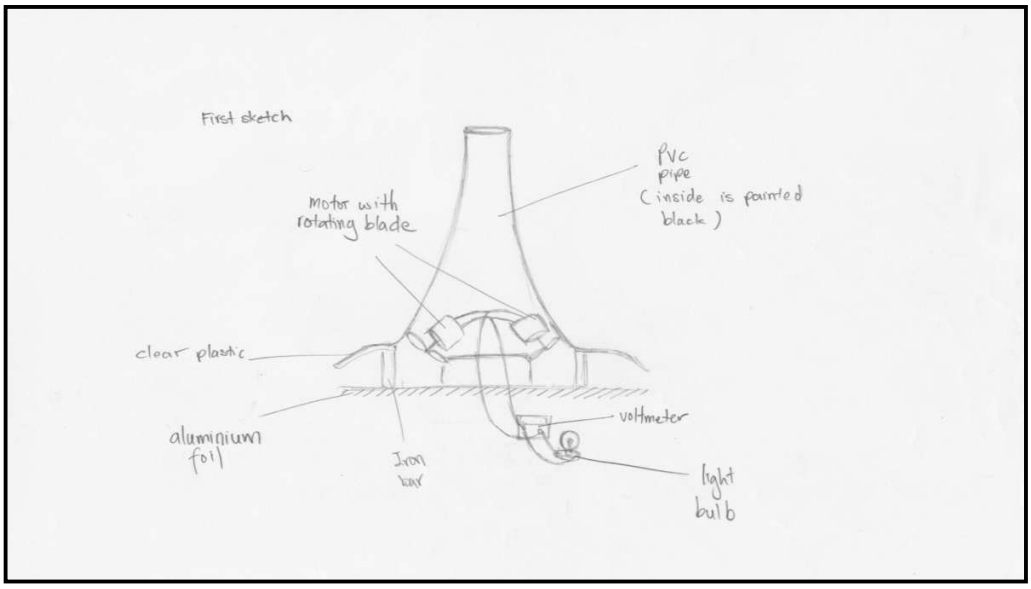


Figure 3.1: First Sketch

3.1.2 Sketch 2

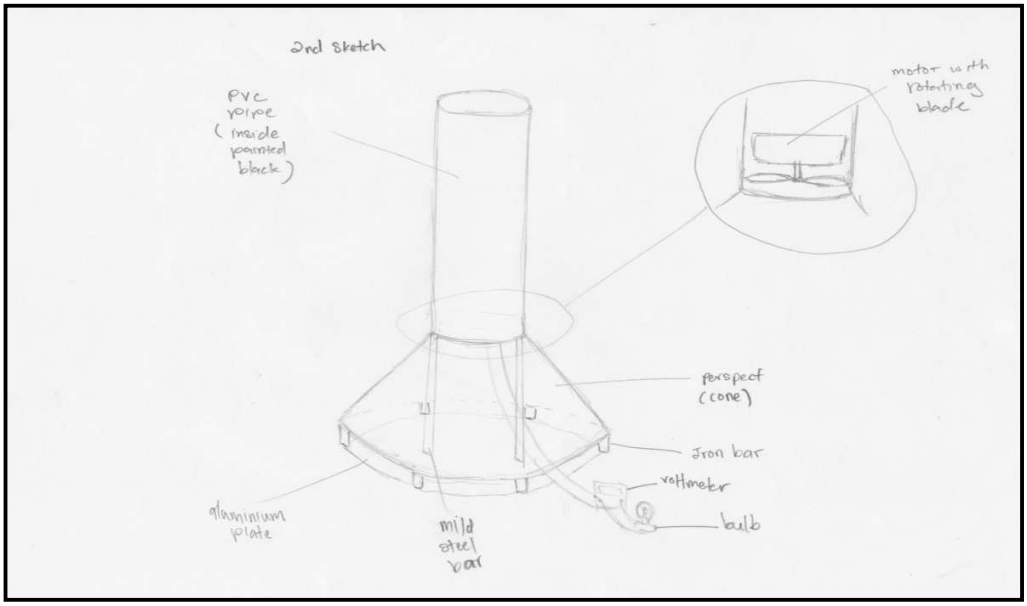


Figure 3.2: Second Sketch

3.1.3 Sketch 3

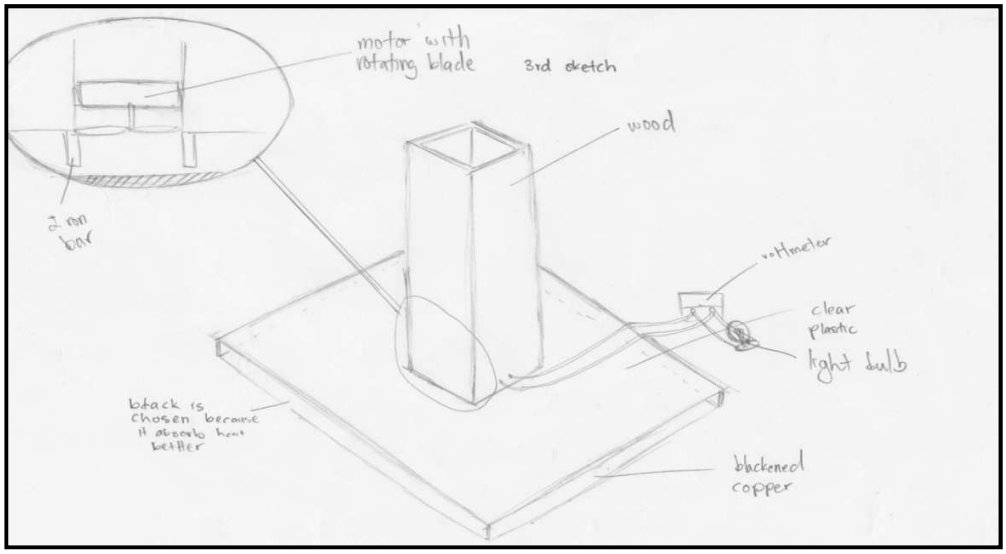


Figure 3.3: Third Sketch